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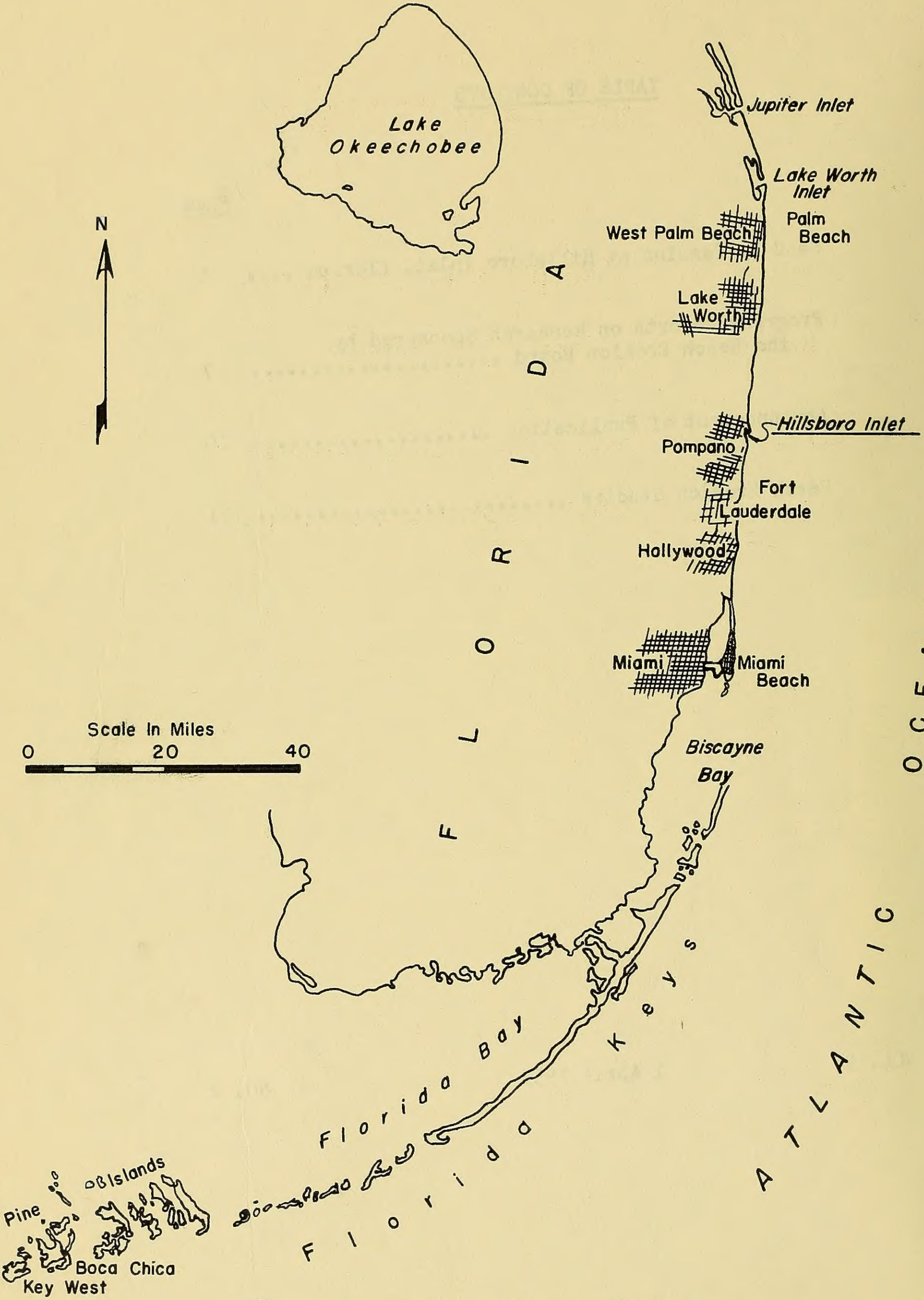

FIGURE 1 · LOCALITY MAP

SAND BY-PASSING AT HILLSBORO INLET, FLORIDA[1]

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Location

Hillsboro Inlet is a natural inlet in Broward County, on the southeast coast of Florida. As shown on Figure 1, the inlet is located about 36 miles north of Miami. The towns of Hillsboro Beach and Pompano Beach are located to the north and south of the inlet, respectively. The United States Coast Guard Hillsboro Lighthouse is located on the shore immediately north of the inlet. The lighthouse was built in 1907.

General Inlet Features

The aerial photograph (Figure 2) depicts the general features of the inlet. The inlet is protected by a rock reef (as indicated in Figure 3) to the north of the inlet; the reef has a length of 580 feet exposed at mean low water, and at a point 70 feet north of the southern end it is about 68 feet wide and 3.5 feet high above the plane of mean low water. Sections normal to the shore indicate that the top of the reef is convex in shape and relatively smooth. The reef has a gradual slope on the seaward side and a very steep slope on the landward side. The rock reef dips as it crosses the mouth of the inlet, giving a controlling depth to rock of 5 to 6 feet at mean low water. The rock rises again above mean low water level at about 600 feet south of the mouth of the inlet. The southern reef is partially exposed at low water and acts as an offshore breakwater. The high water shore line on the south side of the inlet is in effect about 700 feet landward of the reef line.

Prior to improvement, Hillsboro Bay was characterized by a "middleground" shoal. The natural channel in the bay lay between the shoal and the north shore. The channel usually had a controlling depth of about 1 foot (mean low water) across the sand bar at the mouth of the inlet. Residents of the area indicate that at one time the sand bar completely blocked the entrance, and was opened by hand shoveling.

(1) Any inquiries relative to this article should be directed to the author.

Photo by Abrams Aerial Survey Corp.
Feb. 1954

FIGURE 2 · HILLSBORO INLET, FLA.

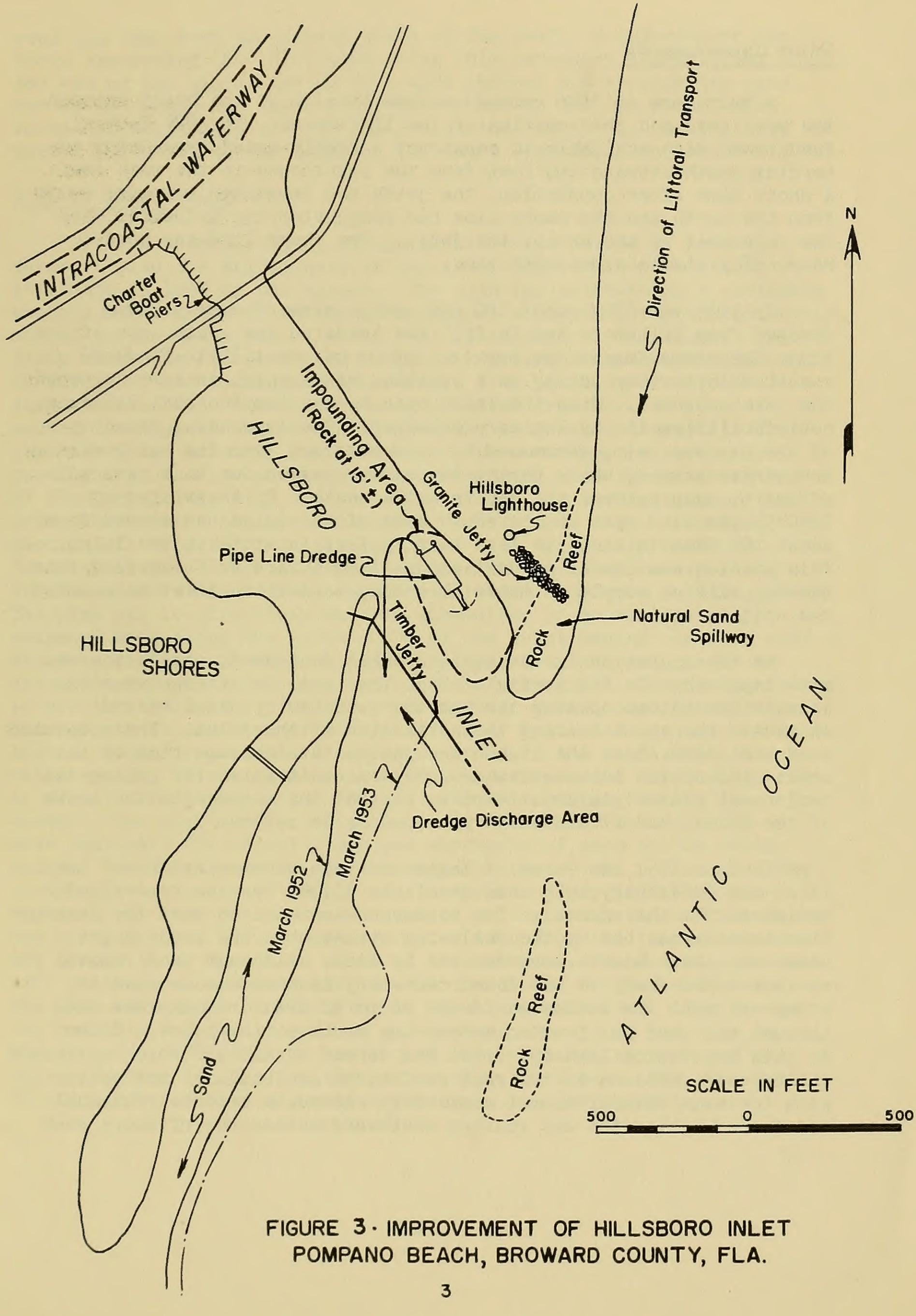

FIGURE 3 · IMPROVEMENT OF HILLSBORO INLET
POMPANO BEACH, BROWARD COUNTY, FLA.

Prior Improvements

A hurricane in 1926 caused serious erosion of the beach between the rock reef and the location of the lighthouse. In 1930 Federal funds were made available to construct a rubble-mound type jetty extending southeastward 260 feet from the lighthouse to the rock reef. A short time after completion, the jetty had impounded littoral drift from the north and the shore line had readjusted its alinement with the rock reef at the end of the jetty. The shore line has been reasonably stable since that time.

In 1946 and 1947 about 100,000 cubic yards of material was dredged from Hillsboro Bay to fill low lands on the south side of the bay. The deepening of the bay (to depths of about 15 to 20 feet) resulted in the bay acting as a settling basin which in turn deepened the inlet channel. With the inlet open to the intracoastal waterway, boat facilities in the bay were enlarged. The impounding capacity of the bay was being decreased by sand entering from the north during the winter season, while during the summer season due to a reversal of drift, sand entered the bay from the south. By the winter of 1950-51 the sand spit on the south side of the inlet had eroded from about 100 feet in width to less than 25 feet in width at the inlet. This erosion was caused by deflection of southward drifting sand into the bay with no supply of material coming across the inlet to nourish the spit.

As the accretion in the bay and inlet continued, navigation was more impaired. In the spring of 1951 the local Inlet Improvements Association cut an opening through the sand bar by dragline and excavated the channel along the north side of the inlet. The excavated sand was piled along the lighthouse jetty. At the same time on the south side of the inlet a timber wall was constructed (of piling and horizontal planks) in an attempt to control the erosion to the south of the inlet, but it proved very temporary in nature.

In June 1951 the Corps of Engineers made an examination of the inlet and in January 1952 made available $2,000 for the removal of boulders from the channel. The boulders were exposed when the examination took place, but by the following winter when the project got under way the boulders were covered by sand. Although sand removal was not authorized, it was found necessary to remove some sand in order to reach the boulders. A cut about 40 feet in width was made through the sand bar located across the mouth of the inlet. Prior to this excavation littoral drift had formed a sand bar which connected the exposed portions of the rock reef north and south of the inlet. With the main channel almost completely closed, a secondary channel had formed behind the bar running southward behind the offshore rock

reef and then turning seaward south of the reef. A majority of the boats traversing the inlet were using this secondary channel. By the end of the winter the 40-foot wide channel cut through the sand bar at the mouth had again started to shoal to such an extent that boats had difficulty in entering or leaving the inlet. During this period the beach to the south of the inlet was continuing to erode.

Plan of Improvement

After a thorough study of the inlet over a period of several years, a plan for maintenance of the inlet was submitted to local interests in 1952 by the author. The plan for maintaining a navigable channel first involved the construction of a timber jetty approximately normal to the ocean shore line on the south side of the inlet. The jetty served to stabilize and build up the narrow beach to the south of the inlet and to protect the channel from shoaling during the summer months when the direction of littoral transport is from the south. During the winter months when the littoral transport is from the north, the material was observed to be entering the harbor by passing over the low portions of the rock reef near the southern end of the rock jetty, with some entering across the low section of the jetty where stone had been displaced by hurricane seas. The low portion of the jetty and rock reef have been very aptly named as "sand spillways". The sand passing over the spillway is deposited in the calmer waters of the harbor area which acts as a stilling basin. The plan was to allow this sand to accumulate in an artificially deepened area along the north shore of the inlet behind the rock reef and when sufficient material had been impounded, the sand would be dredged and by-passed to the south side of the inlet where it is needed to nourish the beach. In this protected bay area a pipe line dredge can operate at any time of the year. After initial dredging, the most logical time for periodic dredging would be in the fall after the rainy season. Dredging at this time would deepen the impounding area to receive the heavy influx of sand over the spillway during the winter. The northeasters which occur in the winter months would move southward the recently dredged stockpile of sand on the south side of the inlet and benefit the areas to the south. This plan was acceptable to the local people and in April and May 1952 they constructed 500 feet of bulkhead and groin on the south side of the inlet and dredged about 10,000 cubic yards of sand from the impounding area and pumped it to the shore south of the bulkhead. Sand moving northward during the summer months in addition to the dredged sand leaves the sand spit south of the inlet in excellent condition. The dredging quantity was not as much as planned and the result was that in the winter of 1952-53, the bar across the inlet had shoaled and was again creating trouble for the boats using the inlet. The sand spit to the south had also begun to erode again, as the direction of

littoral movement was then southward. Local interests again raised money to dredge the impounding area. Between January 15-24, 1953 a 12-inch pipe line dredge removed about 40,000 cubic yards of sand from the impounding area and discharged it on the south shore. The impounding area was dredged to about 20 feet below mean low water. When the work was completed the inlet mouth was wide, had scoured to rock and was in excellent condition for navigation.

By the fall of 1954 the impounding area had about filled to capacity and the shore south of the inlet needed nourishment. In January 1955, 60,000 cubic yards were dredged from the impounding area and placed on the south shore. Experience to date indicates that for best results for both navigation and beach restoration, maintenance dredging in amount of about 75,000 cubic yards should be performed during the fall of each year.

Concluding Remarks

Consideration is now being given to a permanent pumping installation with special features but of simple design, mounted on a barge, for regular maintenance at this inlet. A single fixed spud mooring will be left in place at the settling basin, from which the pump barge will operate. When not in use, and especially during adverse weather, the pump barge will be berthed elsewhere for safety.

It is believed that for better beach protection the south jetty built by local interests, should be extended to the original recommended length of 700 feet. It was shortened to 450 feet in order to obtain steel piling to reinforce its present seaward end.

This plan appears to offer control of the inlet from a navigation standpoint and to provide sand nourishment to the shore south of the inlet, both features being accomplished at an annual cost within the means of local interests. The success of this plan at Hillsboro Inlet suggests that similar approaches, with sand "spillways" constructed on a wholly artificial basis, might be considered at other inlets.

PROGRESS REPORTS ON RESEARCH SPONSORED BY THE BEACH EROSION BOARD

Abstracts from progress reports on several research contracts in force between universities or other institutions and the Beach Erosion Board, together with brief statements as to the status of research projects being prosecuted in the laboratory of the Beach Erosion Board are presented as follows:

I. University of California, Contract No. DA-49-005-eng-8, Status Report No. 17, 1 October 1954 through 31 January 1955

A report entitled "Movement of Sand Around Southern California Promontories" has been 90 percent completed. This report embodies the results of the past 18 months of work on the movement of sand around Points Arguello, Conception and Dume in Southern California, which has shown very clearly that sand moves around these promontories. It moves in three distinct ways: (1) along the beach and surf zone; (2) in the water from sea level to a depth of 30 feet; and (3) in depths between 30 and 60 feet. Beyond the depth of 60 feet, little sand is in the process of movement. Movement of sand in the surf zone is interrupted by the rocky promontories, and whatever sand moves around the points is either carried in the surf by the turbulent action of the waves, or moves along the sandy bottom at the foot of the promontories. None of these promontories extends beyond a 30-foot depth, and hence sand in the 30-60-foot zone moves uninterruptedly around the points. In the shallower zones where the normal progress of motion is interrupted, the turbulent action of the waves is sufficient to keep the sand in suspension; thus if there is a net set of current, sand is moved around the points.

Another report on beach changes at Point Reyes is in preparation. This beach is exposed to the open ocean and is at right angles to the prevailing wind and waves with a fetch of more than 2,000 miles; the beach receives large waves at times of storms. The report will show the areal and seasonal variations in beach characteristics, measurements having been obtained at a series of locations along the beach 5 times during the past 18 months.

II. University of California, Contract DA-49-005-eng-17, Status Reports 7 and 8, October 1954 through March 1955.

The experimental work, which consisted of obtaining (1) the forward and backward velocity of motion of the sediment bed oscillating under still water, (2) the sediment transport rates, and (3) the velocities of travel, heights, wave lengths and shapes of ripples generated on the bed, was completed.

A technical report, dealing with the mechanics of sediment motion caused by the action of surface waves of large wave length and small amplitude in relatively deep water and with the transportation of sediment in shallow water due to the action of differential velocities existing under waves, was essentially completed.

III. University of California, Contract No. DA-49-005-eng-31, Status Report No. 6, 1 October 1954 to 1 February 1955

The three reports dealing with water surface roughness and shear stress, and wind waves and set-up in shallow water were completed.

IV. University of California, Contract No. DA-49-055-eng-44, Status Report Nos. 2 and 3, 1 October 1954 through 31 March 1955

Photographic data were taken in the ripple tank for five water depths and five wave periods for each of three different beach slopes (1:20, 1:40 and 1:60) and for three wave angles (15, 34, and 50 degrees) for each slope. Analysis of these data indicates that Snell's law predicts the refraction angle with acceptable accuracy although there is experimental scatter.

V. Scripps Institution of Oceanography, Contract No. DA-49-055-eng-3, Quarterly Progress Report No. 22, October-December 1954

The maximum cut yet observed in the 21 months of reference-rod studies occurred at the 30-foot depth during December. It coincided with a period of unusually low, long-period ocean swells. The maximum changes now stand at 0.26, 0.16, and 0.07 feet in areas where the water depth is approximately 30, 52, and 70 feet respectively.

A preliminary paper describing the physical aspects of ripples generated by wave motion in shallow water is in preparation. The ripple studies were extended to the Coronados Islands, Guadalupe Island, Mexico and an area off Point Loma; information gained in these areas has strengthened the validity of the earlier findings and indicates that they have a general application.

A strong scattering layer (similar to one found three years ago) was observed in the head of Scripps Submarine Canyon during one of the surveys this quarter. The November survey indicated that the canyon is still being filled, however the earthquake of 12 November started a small slide in the sandy sediment in Sumner Branch.

VI. The Agricultural and Mechanical College of Texas, A & M Project 95 Quarterly Report for period ending 14 December 1954, Cont.No. DA-99-055-eng-45

Construction of wave refraction diagrams for various locations has continued, and deep water wind-wave hindcasts were made for the five locations in the Gulf of Mexico for a 6 month series of weather

maps. A technical report dealing with a graphical technique for forecasting waves was in preparation.

VII. Massachusetts Institute of Technology. Contract No. DA-49-055-eng-16, Status Report dated 15 March 1955

The experimental program has been completed. Analysis of all data on both the wave characteristics and the sediment motion was continued and has been essentially completed. A report presenting the results of this analysis is being prepared.

VIII. Waterways Experiment Station, Vicksburg, Mississippi

Wave Run-up Study:
Testing was completed on the recurved wall, and testing was initiated on a riprap-faced seawall with a seaside slope of 1 on 1½.

IX. Beach Erosion Board, Research Division, Project Status Report for Quarter ending 15 March 1955

In addition to the research projects under contract to various institutions which are reported on above, the Research Division of the Beach Erosion Board is carrying out certain projects with its own facilities. The main unclassified projects have been described in previous numbers of the Bulletin, and a short description of some of the work accomplished through the last quarter is given below:

Measurement of Suspended Material in Laboratory Wave Tanks - A series of suspended samples were taken in and near the surf zone with a pump type sampler for laboratory use to determine best sampling methods. Location of the sampler intake with respect to ripple crest and trough appears to influence results, greater concentrations being observed over the ripple crests. Water temperature also appears to affect the concentrations observed, much higher concentrations occurring with lower temperatures.

Wave Run-up on Permeable Slopes - Testing of wave run-up on permeable beach slopes has been initiated, the first slope tested being 1 on 10. Results obtained will determine the effect of both sand grain roughness and permeability.

Routine progress, testing and analysis have been made on other projects being carried out by the Research Division. In addition, Research Division reports on "Laboratory Study of Effect of Tidal Action on Wave-Formed Beach Profiles" by G. M. Watts and R. F. Dearduff; "Laboratory and Field Tests of Sounding Leads" by G. M. Watts; "North Atlantic Coast Wave Statistics Hindcast by Bretschneider-Revised Sverdrup-Munk Method" by T. Saville Jr.; "Laboratory Study of Shock Pressures of Breaking Waves" by C. W. Ross; "Generalized Laboratory Study of Tsunami Run-up" by K. Kaplan, and "The Effect of Fetch Width on Wave Generation" by T. Saville Jr., were completed and published

as Technical Memorandums No. 52, 54, 55, 59, 60, and 70 respectively; an Engineering Division Report "Restudy of Test - Shore Nourishment by Offshore Deposition of Sand, Long Branch, New Jersey" by R. L. Harris was published as Technical Memorandum No. 62. Also a report "North Atlantic Coast Wave Statistics Hindcast by the Wave Spectrum Method" by G. Neumann and R. W. James was published as Technical Memorandum No. 57, resulting from a contract investigation made for the Beach Erosion Board. One additional report "Wave Forces on Piles: A Diffraction Theory" by R. C. MacCamy and R. A. Fuchs was submitted and published as Technical Memorandum No. 69.

ANNOUNCEMENT OF PUBLICATION

Technical Report No. 4 of the Beach Erosion Board, entitled "Shore Protection Planning and Design", is available to the public. Copies of this publication may be purchased from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for $2.25.

This report presents a compilation of available knowledge useful to engineers concerned with the science of shore protection. The book is divided into two parts, - Functional Planning and Structural Design, and contains six appendices, - Glossary of Terms, List of Common Symbols, Bibliography, Miscellaneous Tables and Graphs, Miscellaneous Derivations, and Example Beach Erosion Control Study. (390 pp. - incl. 187 illus.)

BEACH EROSION STUDIES

Beach erosion control studies of specific localities are usually made by the Corps of Engineers in cooperation with appropriate agencies of the various States by authority of Section 2 of the River and Harbor Act approved 3 July 1930. By executive ruling the costs of these studies are divided equally between the United States and the cooperating agencies. Information concerning the initiation of a cooperative study may be obtained from any District or Division Engineer of the Corps of Engineers. A list of authorized cooperative studies follows:

AUTHORIZED COOPERATIVE BEACH EROSION STUDIES

MASSACHUSETTS

PEMBERTON POINT TO GURNET POINT. Cooperating Agency: Department of Public Works.

Problem: To determine the most suitable methods of shore protection, prevention of further erosion and improvement of beaches, and specifically to develop plans for protection of Crescent Beach, the Glades, North Scituate Beach and Brant Rock.

CHATHAM. Cooperating Agency: Department of Public Works.

Problem: To determine the best method of preventing shoaling of Stage Harbor and damage to shore property, and the effects on Stage Harbor and adjacent shore property of probable changes to Nauset Beach and Monomoy Island and any works which may be constructed for protection of Stage Harbor.

CONNECTICUT

STATE OF CONNECTICUT. Cooperating Agency: State of Connecticut (Acting through the Flood Control and Water Policy Commission)

Problem: To determine the most suitable methods of stabilizing and improving the shore line. Sections of the coast are being studied in order of priority as requested by the cooperating agency until the entire coast has been included.

NEW YORK

N. Y. STATE PARKS ON LAKE ONTARIO. Cooperating Agency: Department of Conservation, Division of Parks.

Problem: To determine the best method of providing and maintaining certain beaches and preventing further erosion of the shore at the Braddock Bay area owned by the State of New York

FIRE ISLAND INLET AND VICINITY: Cooperating Agency: Long Island State Park Commission

Problem: To determine the most practicable and economic method of providing adequate material to maintain the shore in a suitably stable condition and an adequate navigation channel at Fire Island Inlet.

SUFFOLK COUNTY (ATLANTIC COAST BETWEEN MONTAUK POINT AND FIRE ISLAND INLET). Cooperating Agency: Department of Public Works, State of New York.

Problem: To determine the most practicable and economic method of restoring adequate recreational and protective beaches and providing continued stability to the shores.

NEW JERSEY

STATE OF NEW JERSEY. Cooperating Agency: Department of Conservation and Economic Development.

Problem: To determine the best method of preventing further erosion and stabilizing and restoring the beaches, to recommend remedial measures, and to formulate a comprehensive plan for beach preservation or coastal protection. The current study covers the shore from Barnegat Inlet to Cape May.

DELAWARE

STATE OF DELAWARE. Cooperating Agency: State Highway Department

Problem: To formulate a comprehensive plan for restoration of adequate protective and recreational beaches and a program for providing continued stability of the shores from Kits Hummock on Delaware Bay to Fenwick Island on the Atlantic Ocean.

NORTH CAROLINA

CAROLINA BEACH. Cooperating Agency: Town of Carolina Beach.

Problem: To determine the best method of preventing erosion of the beach.

CALIFORNIA

STATE OF CALIFORNIA. Cooperating Agency: Department of Public Works, Division of Water Resources, State of California

Problem: To conduct a study of the problems of beach erosion and shore protection along the entire coast of California. The current studies cover the Santa Cruz, Orange County San Diego and Humboldt Bay Areas.

WISCONSIN

MANITOWOC-TWO RIVERS. Cooperating Agencies: Wisconsin State Highway Commission, Cities of Manitowoc and Two Rivers

Problem: To determine the best method of shore protection and erosion control.

MICHIGAN

BERRIEN COUNTY. Cooperating Agency: City of St. Joseph

Problem: To determine the most effective methods of preventing erosion of the shore by waves and currents.

TERRITORY OF HAWAII

WAIMEA & HANAPEPE, KAUAI. Cooperating Agency: Board of Harbor Commissioners, Territory of Hawaii.

Problem: To determine the most suitable method of preventing erosion and of increasing the usable recreational beach area, and to determine the extent of Federal aid in effecting the desired improvement.

CALIFORNIA

STATE OF CALIFORNIA. Cooperating Agency: Department of Public Works, Division of Water Resources, State of California.

Problem: To conduct a study of the problems of beach erosion and shore protection along the entire coast of California. The current studies cover the Santa Cruz, Orange County, San Diego and Humboldt Bay areas.

WISCONSIN

MANITOWOC-TWO RIVERS. Cooperating Agencies: Wisconsin State Highway Commission; Cities of Manitowoc and Two Rivers.

Problem: To determine the best method of shore protection and erosion control.

MICHIGAN

BERRIEN COUNTY. Cooperating Agency: City of St. Joseph.

Problem: To determine the most effective methods of preventing erosion of the shore by waves and currents.

TERRITORY OF HAWAII

WAIMEA & [illegible], KAUAI. Cooperating Agency: Board of Harbor Commissioners, Territory of Hawaii.

Problem: To determine the most suitable method of preventing erosion and of improving the (badly deteriorated) beach area, and to determine the extent of Federal aid in effecting the desired improvements.